Appendix Q1

Introduction to Appendix Q

SHELL E&P IRELAND LIMITED

CORRIB GAS FIELD DEVELOPMENT PROJECT

Corrib
natural gas

Q1 – INTRODUCTION TO APPENDIX Q

DOCUMENT No: COR-25-SH-0010

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1 EXECUTIVE SUMMARY

The purpose of Appendix Q of the Corrib Onshore Pipeline Environmental Impact Statement (EIS) is to demonstrate that the Corrib Onshore Pipeline does not pose an unacceptable risk to the general public and meets all relevant international and Irish safety criteria. The Appendix has been prepared following detailed technical analysis of the issues highlighted by An Bord Pleanála in their request dated 2nd November for further information in respect of the design of the Corrib onshore pipeline and subsequent correspondence (29th January 2010). Modifications to the design and operation of the pipeline have been proposed in response to the issues raised, and Appendix Q demonstrates that the Onshore Pipeline as now proposed satisfies the new criteria specified by An Bord Pleanála.

The detailed information provided in Appendix Q reflects An Bord Pleanála's stated objective in terms of assessing worst-case scenarios in terms of safety. While SEPIL remains of the opinion that the designs and routes previously proposed for the Onshore Pipeline were safe and fully in accordance with the Codes and Standards designated by the Regulator (Minister for Communications, Energy and Natural Resources), SEPIL has now made further key revisions to its proposals. The route of the pipeline has been modified so that a large proportion of the pipeline will be routed in a tunnel under Sruwaddacon Bay. This has the effect of optimising the distance to occupied dwellings. SEPIL has also reduced the Maximum Allowable Operating Pressure (MAOP) in the Offshore and Onshore Pipeline sections to 150 barg and 100 barg respectively. The pressure in the Onshore Pipeline is now significantly less than the maximum pressure recommended following the Independent Safety Review carried out by Advantica in 2006. The Onshore Pipeline has, over the last number of years, been the subject of several independent safety reviews and reports commissioned by the Minister for Communications, Energy and Natural Resources ("The Minister"), who has statutory responsibility for the upstream oil and gas safety regime in Ireland. The Onshore Pipeline design meets all of the appropriate recommendations arising from these Reviews.

The Onshore Pipeline complies with those pipeline Codes and Standards designated for the Onshore Pipeline by the Technical Advisory Group (TAG) to the Minister. The application of these Codes and Standards for the design, construction and operation of the Onshore Pipeline will ensure that the risk levels associated with the pipeline are extremely low as demonstrated in analyses included in this Appendix Q.

An Bord Pleanála's correspondence specified both risk and consequence based criteria that should apply to the Onshore Pipeline. The risk criteria specified reflect international norms, but the consequence or hazard criterion specified appears to imply that 'hazard distance', taken in isolation from the associated risk, should be applied so as to define proximity distances for the Onshore Pipeline. Such an approach is not required by the designated Codes and Standards and SEPIL and their advisers are not aware of such an approach having been applied to any other gas pipelines in Ireland or Western Europe. It should also be noted that the recently enacted safety legislation (the Petroleum (Exploration and Extraction) Safety Act 2010) makes specific reference to a 'risk-based' safety framework, more specifically a safety case regime, which implies that the application of 'risk' is central in such matters. SEPIL does not consider that the principle of the application of consequence based criteria, without having regard to the extremely low likelihood of a worst-case event, should be applied as the sole criterion in determining the proximity of gas pipelines to dwellings. Nevertheless, this Appendix Q provides the detailed analysis which demonstrates that the exacting requirements regarding An Bord Pleanála's adoption of *"the appropriate hazard distance for the pipeline in the event of a pipeline failure"* are met in full.

The implementation of Petroleum (Exploration and Extraction) Safety Act 2010 will transfer statutory responsibility for the regulation of safety for upstream petroleum infrastructure such as the Corrib pipeline from the Minister for Communications Energy and Natural Resources to the Commission for Energy Regulation. This legislation provides for ongoing safety regulation and certification of designated upstream petroleum activities through a safety case regime, similar to that in place for the downstream gas industry in Ireland, including the Irish gas transmission network as well as gas storage and LNG facilities.

Appendix Q provides detailed information on all of the technical and safety issues raised by An Bord Pleanála in their correspondence.

Attachment Q1A tabulates the queries raised, and provides a cross-reference to the individual responses included within Appendix Q.

Attachment Q1B provides an overview of additional information presented at the request of An Bord Pleanála, to cover the incidental and individual documents presented at the 2009 Oral Hearing.

2 BACKGROUND

2.1 OBJECTIVE OF APPENDIX Q

Appendix Q of the Environmental Impact Statement has been prepared to provide a transparent and adequate demonstration that the Onshore Pipeline meets applicable Irish and international requirements relating to public safety, and also meets the additional requirements set out in correspondence by An Bord Pleanála.

2.2 SCOPE OF APPENDIX Q

The scope of Appendix Q is to provide a detailed overview of how all issues affecting the safety in design and the future integrity of the Onshore Pipeline have been and will be managed in future.

It should be noted that this Appendix Q includes greater detail than would normally be included in an EIS, so as to respond appropriately to the various safety concerns raised by An Bord Pleanála.

Appendix Q also provides information relevant to the offshore sub-sea wells and manifold at the Corrib Field. While these facilities are outside the scope of the proposed Onshore Pipeline Development and the Onshore Pipeline EIS, and are the subject of other regulatory approvals and consents, this additional information is provided because the offshore facilities have a direct bearing on the gas pipeline pressure regime upstream of the Landfall Valve Installation (LVI) at Glengad.

It should be noted that a significant degree of geotechnical analysis has also been completed in respect of the proposed route of the Onshore Pipeline. This information is contained in Appendix M of this Environmental Impact Statement. The outputs from the analysis contained within Appendix M have been used in the relevant pipeline design, risk and integrity analyses contained within Appendix Q.

2.3 STRUCTURE OF APPENDIX Q

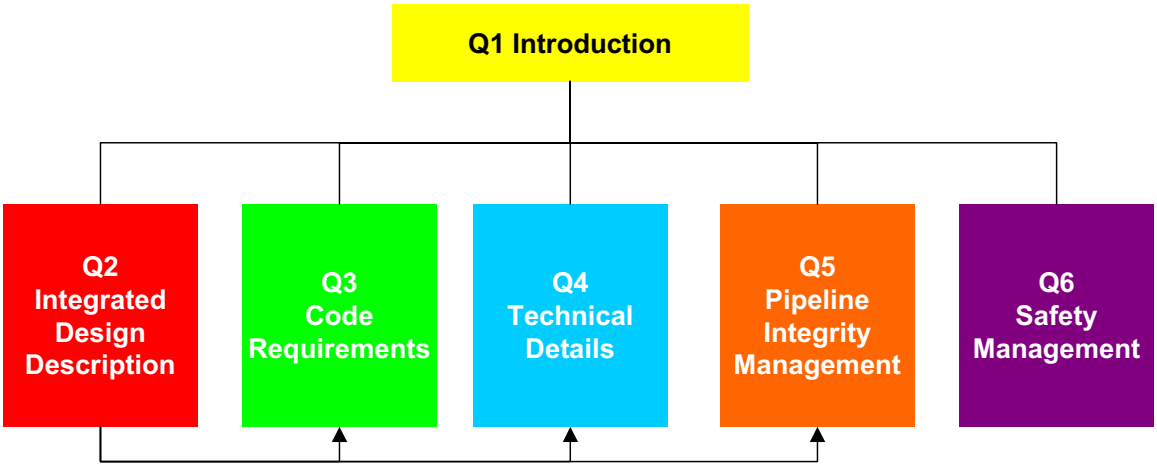
An Bord Pleanála has requested that SEPIL *"provide an integrated set of design documentation in the form of a revised Appendix Q. The documentation should integrate the analysis provided in the incidental and individual documents at the oral hearing".*

Appendix Q therefore provides an integrated set of documentation that draws together the individual documents that have been produced by different specialists and technical experts.

2.3.1 Schematic Summary

A schematic summary of Appendix Q is provided in Figure 2.1 below.

Figure 2.1: Appendix Q Structure



Section Q2 summarises the design approach.

Section Q3 describes the Codes and Standards that are applicable.

Section Q4 provides an overview of the design and includes a review of issues such as settlement of the stone road, the safety shutdown and over-pressure protection systems, corrosion and other 'unprocessed gas' issues.

Section Q5 discusses the pipeline integrity management system.

Section Q6 discusses the safety-specific aspects of the Onshore Pipeline and includes the Qualitative and Quantitative Risk Assessments, along with the analysis requested by An Bord Pleanála in Section 3(b) of their 2nd November 2009 letter. An outline of the approach to Emergency Response Planning is also included.

3 INTEGRATED DESIGN DESCRIPTION

3.1 PIPELINE ROUTE

The route of the Onshore Pipeline is discussed in the EIS (see Chapter 4). A large proportion of the onshore pipeline will be installed in a 4.9 km tunnel between Glengad and Aghoos, under Sruwaddacon Bay.

3.2 DESCRIPTION OF THE PIPELINE

Chapters 4 and 5 of the EIS describe the Onshore Pipeline and summarise the key construction matters.

The Onshore Pipeline is a 20” diameter, 27.1 mm nominal wall thickness carbon steel pipeline.

Installed parallel to the Onshore Pipeline will be a number of supplementary services, including:

- A fibre optic cable and a signal cable
- An umbilical, which will provide electrical and hydraulic power, communications as well as methanol and treated produced water from the Bellanaboy Bridge Gas Terminal through to the Subsea facilities. The onshore umbilical will comprise three individual multi-core cables.
- An outfall pipeline to transport treated surface water from the Gas Terminal to a diffuser at a permitted outfall point north of Erris Head outside Broadhaven Bay cSAC.

The above details are discussed in Appendix Q4.1.

4 LEGAL AND CODE REQUIREMENTS

4.1 REGULATORY CONTROL

The Minister for Communications, Energy and Natural Resources ('the Minister') has responsibility for the regulation of petroleum exploration and production activity in Ireland. This responsibility includes responsibility for the safe design, construction and operation of the Corrib offshore and onshore pipeline.

The onshore pipeline design and route, as approved in 2002, were subject to comprehensive technical and safety review by the Minister's advisers, and the associated consents provided for a process of independent third party verification of the design and construction of the Corrib facilities including the onshore pipeline. A Quantitative Risk Assessment was prepared by SEPIL's consultants to demonstrate that the risk levels associated with the pipeline met normally accepted levels in the gas pipeline industry.

In 2005 the statutory control and supervision aspects of the safety and integrity of the Corrib pipeline were further strengthened by the Minister's appointment of the Technical Advisory Group, specifically tasked with regulating the safety of the Corrib project.

4.2 IMPLICATIONS OF THE PETROLEUM (EXPLORATION AND EXTRACTION) SAFETY ACT 2010

Following the recent enactment of the Petroleum (Exploration and Extraction) Safety Act 2010 the statutory responsibility for the regulation of upstream oil and gas safety (which includes the Onshore Pipeline) will transfer from the Minister to the Commission for Energy Regulation, ("the Commission"). The Commission is already responsible for regulating safety relating to downstream gas infrastructure.

Under the new legislation the Commission is empowered to establish a safety framework, to monitor and to enforce safety compliance, and to issue safety permits for upstream petroleum activities.

The Act provides for a prohibition on all petroleum undertakings from carrying out designated petroleum activities, unless a safety permit from the Commission is in force in respect of the designated petroleum activity concerned. There is a prescribed time frame within which established petroleum undertakings must obtain a safety permit.

The new risk-based legislative requirements include the following provisions:

- Petroleum activities are to be carried out in a manner to reduce any risk to safety to a level that is As Low As Reasonably Practicable (ALARP);
- Petroleum infrastructure is to be designed, constructed, installed, maintained, modified, operated and decommissioned in such a manner as to reduce any risk to safety to a level that is ALARP;
- The construction and installation of petroleum infrastructure is to be sound and fit for the purpose for which it has been designed;
- Safe operating limits are to be established;
- The standards of safety and training of personnel are to be such that personnel are competent;

- Procedures are to be prepared and implemented so as to ensure that the risk of an incident is as low as is reasonably practicable;
- Emergency plans must be in place;
- Incidents are to be reported.

Under the new legislation, a Safety Case will be required for all designated petroleum activities. The Safety Case will have to demonstrate that risks are properly assessed and effectively controlled to ALARP levels.

The Commission will be empowered to issue safety permits where, having reviewed the Safety Case, it is satisfied that the petroleum undertaking involved has a proper safety management system. The Commission will also have the power to refuse to issue a safety permit, or to revoke a safety permit, in circumstances associated with non-compliance, and in such cases, the infrastructure concerned cannot be operated.

The passing of the new legislation implements an important recommendation of the Advantica Independent Safety Review, 2006 (see Section 7 Final Remarks and Recommendations, p. 57).

The Minister for Communications, Energy and Natural Resources is and will continue to be responsible for the upstream oil and gas safety regime until the relevant order(s) to be issued in relation to the Petroleum (Exploration and Extraction) Safety Act are made.

4.3 REGULATORY REVIEW OF THE PIPELINE DESIGN

The design of the onshore pipeline incorporated in this application by SEPIL for the consent to construct the Onshore Pipeline complies with the requirements arising from a number of detailed and independent regulatory reviews, which are briefly discussed below.

4.3.1 Review by Mr. Andrew Johnston

In March 2002, on behalf of the Department of Marine and Natural Resources, Mr. Andrew Johnston, an independent consultant, carried out a review of the pipeline design and concluded that the pipeline would meet public safety requirements as outlined in the selected design code, provided his recommendations were applied. The Minister granted consent for the pipeline subject to the implementation of Mr Johnston's recommendations.

4.3.2 Review by AEA Technology

In 2005, again on behalf of the Department of Marine and Natural Resources, an independent review of the Quantitative Risk Assessment (QRA) of the Onshore Pipeline was conducted by AEA Technology (an independent science and engineering services company operating in a range of market sectors, including Safety and Risk). AEA Technology commented on the QRA Report and agreed with its overall findings, concluding that the prediction of risks to the public resulting from the operation of the Onshore Pipeline indicated that the risks were tolerable when compared with International criteria.

4.3.3 The Advantica Independent Safety Review

In 2005 the Minister for Communications, Marine & Natural Resources appointed Advantica to carry-out a detailed safety review of the proposed Onshore Pipeline. Advantica is one of the world's leading specialist gas engineering companies.

The Advantica report was published on the 3rd of May 2006 following two separate rounds of public consultation. The review concluded *inter alia* that *"there will be a substantial safety margin in the pipeline design … and that the pipeline design and proposed route should be accepted as meeting or exceeding international standards in terms of acceptability of risk",* provided that certain recommendations were followed. These recommendations included the modification of the beach valve above ground installation so as to ensure that the pressure in the onshore section of the pipeline would be limited to 144 barg although the pipeline was originally designed to withstand the maximum pressure from the Corrib gas reservoir. The Advantica Independent Safety Review continues to be relevant to the current design of the Onshore Pipeline. The design complies with the recommendations made by Advantica in their report and Appendix Q3.1 contains a table that shows how SEPIL has met these recommendations.

4.3.4 The Technical Advisory Group

The work of Advantica was supervised by a Technical Advisory Group appointed by the (then) Minister for Communications, Marine and Natural Resources (who *inter alia* has statutory responsibility for establishing the safety standards applicable to the upstream oil and gas developments such as the Corrib project).

Following the publication of the Advantica report, the Technical Advisory Group published three reports during 2006 as follows:

- Report of the Corrib Technical Advisory Group to Minister Dempsey.
- Report of the Corrib Technical Advisory Group to Minister Dempsey on an appropriate Inspection and Monitoring Regime for the Corrib Project.
- Corrib Gas Pipeline Safety Issues.

The reports of the Technical Advisory Group established the technical criteria to be applied to the Corrib Gas Pipeline design, and SEPIL's 2009 and current design comply with their requirements.

A statement of how SEPIL has complied with the recommendations of the Technical Advisory Group is provided in Appendix Q3.1.

4.3.5 Review by Mr. Peter Cassells

Mr. Peter Cassells was appointed as Mediator by the (then) Minister for Communications, Marine and Natural Resources in 2005. Mr. Cassells issued his report (Proposed Corrib Gas Pipeline, Report and Recommendations from Mediation) in July, 2006.

His report contains several recommendations, one of which is particularly relevant to this application; namely the modification of the route of the pipeline in the vicinity of Rossport to address community concerns regarding proximity to housing. SEPIL' s applications for consent for the modified Corrib Onshore Pipeline as lodged in 2009 address this recommendation, as does the revised pipeline route described in this (revised) EIS and arising from the invitation of An Bord Pleanála in their letter of 2nd November 2009 for SEPIL to further modify the route.

4.4 CODES AND STANDARDS

The applicable Codes and Standards for the design, construction and operation of the Corrib Onshore Pipeline were set out by the Technical Advisory Group (see reports listed in Section 4.3.4). The designated Codes and Standards are consistent with the Standards applicable to the design, construction and operation of other gas pipelines in Ireland and generally in Western Europe.

The applicable Codes are summarised below, and are discussed in more detail in Appendix Q3.2.

4.4.1 Recommendation of the Technical Advisory Group to the Minister regarding Onshore Pipeline Codes and Standards

The Codes and Standards applicable to the design, construction, operation and maintenance of the Onshore Pipeline are as follows:

- I.S. EN 14161:2004 (Petroleum and Natural Gas Industries – Pipeline Transportation Systems);
- I.S. 328: 2003 (Code of Practice for Gas Transmission Pipelines and Pipeline Installations (Edition 3.1));
- BS PD 8010-1: 2004 (Code of Practice for Pipelines, Part 1: Steel pipelines on land)).

The application of the above Standards complies fully with a key recommendation of the January 2006 Report of the Corrib Technical Advisory Group to the Minister for Communications, Marine and Natural Resources, which recommended that *"The primary pipeline design code is hereby designated by TAG to be IS EN 14161; however IS 328 and PD 8010 shall apply where they exceed IS EN 14161".*

In the subsequent Report to the Minister in March 2006, the Technical Advisory Group (TAG) also recommended: *To be specific, TAG recommends that, while the overall design code for the upstream, onshore section of the Corrib project shall be IS EN 14161, construction, installation, operation and maintenance of the onshore section of the pipeline shall be generally in accordance with IS 328, and the inspection and monitoring regime that will be applied to this section of the project will be as per the relevant provisions of IS 328.*

Where a case is made by the developer and accepted by TAG, specific provisions of PD 8010 may apply in lieu of the relevant provisions of IS 328".

A Design Code Review for the Onshore Pipeline has been carried out and the associated report, which has been approved by TAG, is included in Appendix Q3.3. This review establishes the basis for compliance with the designated Codes and Standards, and is summarised below.

4.4.2 Details of the Pipeline Codes

- **I.S. EN 14161:2004 (Petroleum and Natural Gas Industries – Pipeline Transportation Systems)**

  This is a European Code first published by CEN (Comité Européen de Normalisation – European Committee for Standardisation) in November 2003. It takes into European Standards the international standard ISO 13623:2000 which gives recommendations for the design, materials, construction, testing, operation and maintenance of pipeline systems in the petroleum and natural gas industries, on land and offshore. The standard is applicable to unprocessed natural gas. As a member of CEN, the National Standards Authority of Ireland published this Code as an Irish Standard in April, 2004.

- **I.S. 328: 2003 (Code of Practice for Gas Transmission Pipelines and Pipeline Installations (Edition 3.1))**

  This Code is published by the National Standards Authority of Ireland. In 1987 NSAI published the first edition of Irish Standard 328. It should be noted from the Foreword to the Code that the *"Code of Practice defines minimum and adequate standards and procedures to be used for steel pipelines for the transmission of gas at maximum operating pressure over 16 bar. The upper pressure limit is not defined but in general practice this ranges up to 100 bar".*

  I.S. 328 was originally modelled on the U.K. onshore gas transmission pipeline Standard - IGEM/TD/1 – Steel Pipelines and Associated Installations for High Pressure Gas Transmission, and is analogous to this U.K. Standard. Since it was introduced I.S. 328 has provided the technical basis for the design, construction and operation for gas transmission pipelines in Ireland. This Code is applicable to processed natural gas. The Technical Advisory Group to the Minister stated in 2006:

  "The relevant provisions in IS 328 have been examined and found to be generally appropriate for the upstream, onshore section of the Corrib project. They deliver a coherent philosophy and sufficient guidance to allow developers and monitoring authorities to agree specific actions.

  A further point in their favour is that, as noted above, BGE follows IS 328 for operations and maintenance purposes for onshore gas transmission pipelines.

  To be specific, TAG recommends that, while the overall design code for the upstream, onshore section of the Corrib project shall be IS EN 14161, construction, installation, operation and maintenance of the onshore section of the pipeline shall be generally in accordance with IS 328, and the inspection and monitoring regime that will be applied to this section of the project will be as per the relevant provisions of IS 328.

  Where a case is made by the developer and accepted by TAG, specific provisions of PD 8010 may apply in lieu of the relevant provisions of IS 328".

- **BS PD 8010-1: 2004 (Code of Practice for Pipelines)**

  BS PD 8010 is published by the British Standards Institute; it has three parts:

  - Part 1 applies to steel pipelines on land;
  - Part 2 applies to subsea pipelines;
  - Part 3 provides guidance to the application of pipeline risk assessment.

  The Code is widely used by the UK pipeline industry. It is applicable to the unprocessed gas conveyed by the Onshore Pipeline (unprocessed natural gas) and, as BS 8010, was the Code on which the original Corrib onshore pipeline, approved by the Minister in 2002, was based.

4.4.2.1 Design Code for the Offshore Pipeline and Landfall Installation (LVI) at Glengad

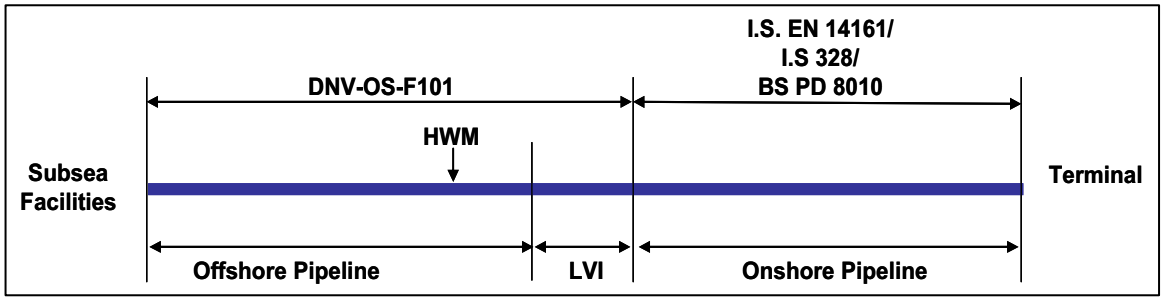
- **DNV-OS-F101 (Offshore Standard – Submarine pipeline Systems)**

  The design code for the offshore pipeline is DNV-OS-F101.

  At the landfall an interface arises between the onshore and offshore pipeline standards, insofar as a different standard is applicable for the offshore section compared to the onshore pipeline. In accordance with the relevant requirements set out in DNV-OS-F101 this interface is the weld between the downstream tee of the Landfall Valve Installation (LVI) and the

onshore pipeline. The Landfall Valve Installation is designed therefore to DNV-OS-F101. This is discussed in more detail in Appendices Q3.2 and Q4.3.

Figure 4.1: Application for Pipeline Design Codes



5 TECHNICAL ISSUES

5.1 GAS PRESSURE

The pipeline design pressure originally selected was 345 barg. This resulted in a pipeline with a thick wall, which greatly contributes to the integrity of the pipeline.

The Advantica Independent Safety Review queried the use of this design pressure for the onshore section, citing concerns associated with the level of uncertainty with the risk modelling which had been carried out for the relevant pressures, the extrapolation of onshore pipeline design codes pressure range, along with societal concerns. Advantica recommended that the pressure in the Onshore Pipeline should be limited to 144 barg. SEPIL accepted this recommendation. Modifications were made to the system and an Onshore Pipeline design pressure of 144 barg was included in SEPIL's planning application to An Bord Pleanála in February 2009.

An Bord Pleanála, in its letter of 2nd November 2009, requested that *"the maximum allowable operating pressure (MAOP) for the pipeline should be stated."*

SEPIL has established the minimum required offshore and onshore pipeline MAOP to maintain a sufficient operating envelope to meet the contractual and technical requirements of the already approved and constructed Gas Terminal. These MAOPs are 150barg and 100barg for the offshore and onshore pipelines respectively.

5.1.1 Definitions of Pressure in the designated Codes

The designated Codes include the following definitions for gas pressure:

- IS EN 14161:2004 defines:
    - The Maximum Allowable Operating Pressure (MAOP) of a pipeline as *"the maximum pressure at which a pipeline system, or parts thereof, is allowed to be operated"*. The corresponding definition in I.S. 328 is MOP or Maximum Operating Pressure, and BS PD 8010 also utilises the term MAOP. For simplicity, the term MAOP is used throughout this Appendix.
    - The Internal Design Pressure as the *'maximum internal pressure at which the pipeline or section thereof is designed in compliance with this European Standard'.* There are comparable definitions in I.S. 328 and BS PD 8010.

5.1.2 Design and Operating Pressures

In this response to An Bord Pleanála's request for further information, SEPIL confirms that the design pressure of the Onshore Pipeline will be limited to 144 barg in accordance with the recommendations in the Advantica Independent Safety Review. The pipeline system test hydrostatic pressures will be 504 barg in accordance with the Standards (see Appendix Q5.3).

SEPIL have set the MAOP of the Offshore Pipeline to 150 barg. This includes the Landfall Valve Installation (LVI) at Glengad. The MAOP of the Onshore Pipeline between the Landfall Valve Installation and the Gas Terminal has been set at 100 barg.

The following table summarises the relevant pressures that will be applicable.

Table 5.1: Applicable Pressures

Location	Design Pressure, Barg	MAOP, Barg
Corrib Offshore Pipeline (up to and including the Landfall Valve Installation)	345	150
Corrib Onshore Pipeline (between the Landfall Valve Installation and the Gas Terminal)	144	100

5.1.3 Operating Pressures and Safeguarding in the pipeline system

The setting of the MAOP values for both the offshore and onshore pipelines, as outlined in Section 2.1, required a review and updating of the Corrib production system operating philosophy.

As described in Appendices Q2.1, Q4.5 and Q4.6 there are 5 layers of safeguarding provided for the pipeline system. These layers can be initiated either by the operators at the Gas Terminal, or else automatically, to ensure that the Corrib System is kept below the defined Maximum Allowable Operating Pressures (MAOPs).

The normal steady state operating pressure at the inlet to the Gas Terminal will be between 80 to 85 barg. Under these conditions, in the case of an upset at the Gas Terminal, there is sufficient capacity in the pipeline system for the operators at the Gas Terminal to quickly stop production from the wells, without tripping the shutdown systems for the LVI.

In the unlikely event that the pressure in the system continues to rise, at 93 barg facilities at the Terminal will automatically send signals to valves at the offshore wells to close.

If the pressure continues to rise at the LVI to 99 barg an automatic signal is initiated at the Landfall Valve Installation, to shut the valves at the LVI, thus isolating the onshore pipeline from the offshore pipeline. If this happens, then the hydraulic fluid in the umbilical connection to the offshore valves will also be released, and these valves will then also close automatically. It should be noted that there will be a continuous 24 hour operations team to oversee production of Corrib gas. The Operators will have ‘push-button’ capability to immediately shut the relevant valves, and so ensure that the system always remains within the defined Maximum Allowable Operating Pressures. Details of the safeguarding system are provided in Appendix Q4.5.

5.2 UNPROCESSED GAS ISSUES

The gas in the Corrib Field is a high quality natural gas, very similar to that produced at the Kinsale Head gas-field and consists of approximately 96% hydrocarbon gas (Methane, Ethane and Propane) and 3% Nitrogen. Small quantities of water and carbon dioxide are also present. To ensure safe and reliable gas production from the Corrib field internal corrosion and hydrate formation must be managed; these are briefly discussed below.

It should be noted that all tests carried out on the Corrib gas samples to date have found no evidence of the presence of hydrogen sulphide. As described in Appendix Q4.7, there is no expectation that

hydrogen sulphide would occur in the Corrib reservoir in the future. Nevertheless routine analysis of gas samples taken will check for Hydrogen Sulphide. It should also be noted that the Advantica Independent Safety Review discussed the issues associated with the gas properties and commented that ***'Pipeline technology for transporting unprocessed gas is well-established, and appropriate measures have been identified to manage these additional hazards'***.

5.2.1 Composition

Appendix Q4.2 provides a product analysis of the gas from the Corrib Field. The following table summarises the principal constituents of the gas that will be carried in the pipeline:

Table 5.2: Principle Constituents of Pipeline Gas

Parameter	Unit	Quantity
Methane, Ethane and Propane	% Mole	95.57
Butane, Pentane & higher (C5+)	% Mole	0.13
Carbon Dioxide	% Mole	0.25
Nitrogen	% Mole	2.61
Water	% Mole	1.09
Methanol (injected)	% Mole	0.35

SEPIL will inject a mixture of methanol and a chemical corrosion inhibitor into the gas at the wellhead, where they will be carried in the gas stream in the Corrib Pipeline.

The gas stream requires minimal processing at the Gas Terminal before entry to the Bord Gáis Éireann gas transmission network.

5.2.2 Internal Corrosion

The small quantities of CO_2 and organic acids in the gas stream have potential to cause a low level of internal corrosion of the Onshore Pipeline. The addition of the corrosion inhibitor, which forms a protective film on the wall of the pipe, prevents significant corrosion occurring. This approach to corrosion mitigation is common in pipelines carrying unprocessed gas. Shell, for instance, has extensive and successful experience (over 40,000 km-years in Europe) with managing internal corrosion.

It is also accepted practice to add additional thickness of metal to the inner surface (i.e. effectively increasing the wall thickness of the pipeline) to allow for the loss of metal over the life of the system, so that at the end of the pipeline's life there is sufficient wall thickness remaining to satisfy the original design requirements. The effective loss of wall thickness in the Onshore Pipeline is calculated to be a maximum of 0.6mm over its anticipated service life, and the pipe wall thickness has been increased therefore by 1mm to allow for such possible corrosion.

It is proposed to continue to check the pipe wall thickness over the life of the Pipeline system. This will be achieved by continuous corrosion monitoring of a section of pipe close to the Corrib field and by carrying out internal inspection of the pipeline at regular intervals. Internal inspection is an established process whereby a pipe inspection gauge (or 'intelligent pig') fitted with a measurement device and

onboard computer is pushed through a pipeline using gas pressure. The 'intelligent pig' will measure and record the pipe wall thickness along the entire length of the Onshore Pipeline to check the degree of any corrosion thus enabling any necessary corrective action to be taken.

The design implications associated with corrosion are discussed in Appendix Q2.1 and the prevention of internal corrosion is also discussed in detail in Appendix Q4.9.

5.2.3 Hydrate inhibition

The Corrib produced gas contains hydrate-forming components such as methane, ethane, propane and carbon dioxide. At high-pressure and low-temperature, these components form crystalline solids known as "gas hydrates". This can occur in pipelines carrying unprocessed gas with inadequate hydrate inhibition. Thus, the prevention of gas hydrates is an important flow-assurance issue since a hydrate blockage may lead to production losses.

To ensure that hydrates do not form in the Offshore and Onshore Pipeline a hydrate inhibitor (methanol) will be added to the gas at the wellhead. Hydrates only have the potential to form if methanol is not injected in sufficient quantities. The operating strategy for Corrib is to immediately stop production in the unlikely event of offshore methanol injection being unavailable. The detailed approach for dealing with hydrates is discussed in Appendix Q4.5.

6 PIPELINE INTEGRITY MANAGEMENT

Pipeline integrity management has been applied within the design, material specification and manufacture of the component parts of the Corrib Pipeline and has included extensive application of independent verification of quality control and assurance. During construction and commissioning of the pipeline the same rigorous approach will continue with a similar application of independent verification. This is described in Appendix Q5.1.

During the operational phase SEPIL intends to provide a high-quality approach to the management of the Corrib pipeline system, which will be based on the extensive experience that Shell has developed in safely operating pipelines in Europe and elsewhere. SEPIL's intent is described in the Pipelines Integrity Management System (PIMS) that describes the operational processes that will be applicable for all elements of the Corrib pipeline facilities, including the Onshore Pipeline, the umbilical lines and water outfall. These operational processes are designed to ensure that the pipeline system is managed appropriately at all times to ensure integrity over the life of the system. The Pipelines Integrity Management System is described in Appendix Q5.2.

7 PIPELINE SAFETY MANAGEMENT

Appendix Q6 contains documents that address the safety-specific aspects of the Corrib onshore pipeline and LVI design. The relationship between the documents contained in Appendix Q6 and other Sections of Appendix Q is shown in Figure 7.1.

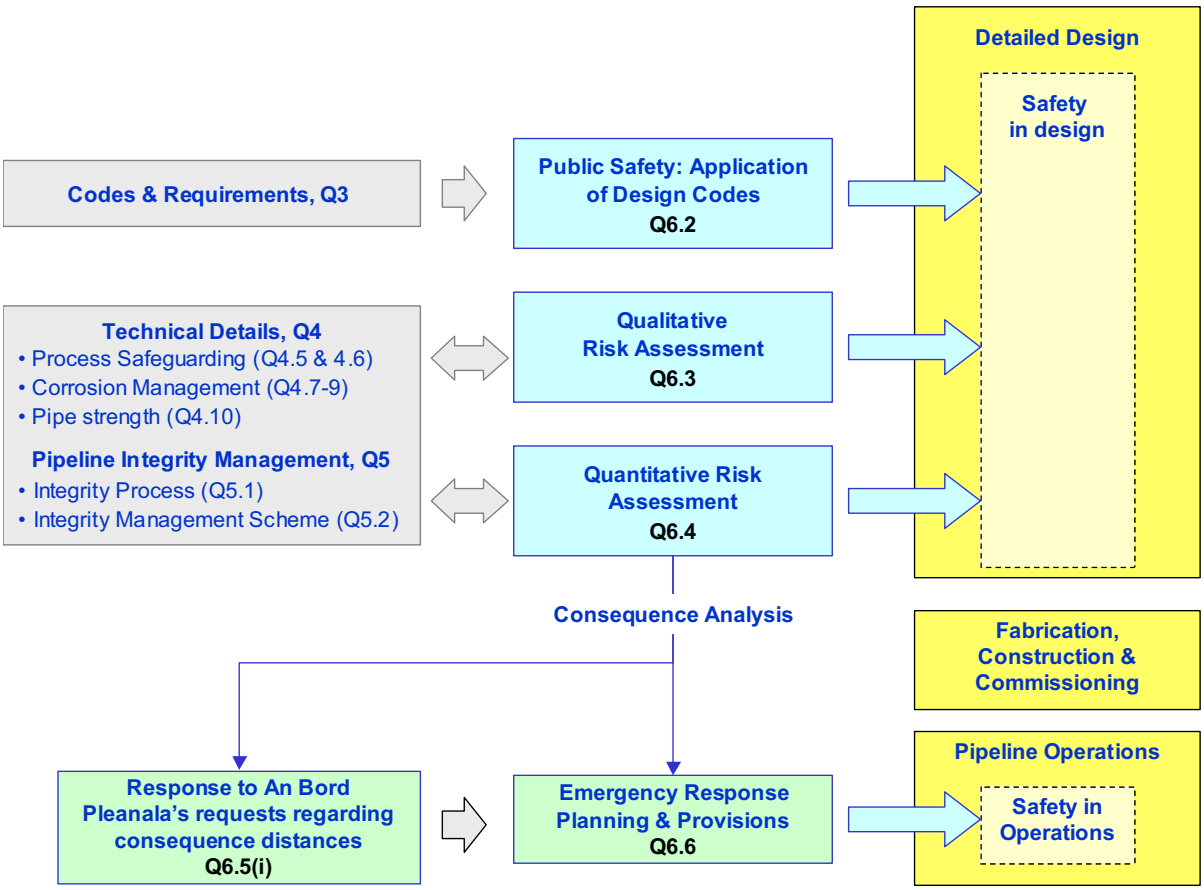


Figure 7.1: Appendix Q6 Document Relationships

7.1 PUBLIC SAFETY: APPLICATION OF DESIGN CODES

The pipeline is designed to be in full conformance with the designated Codes, and will also meet the additional requirements specified by An Bord Pleanála in correspondence. Key issues are discussed below.

7.1.1 Design Factor & Wall Thickness

The designated Codes applicable to the Onshore Pipeline stipulate requirements relating to the route selection of a gas pipeline, the calculation of the pipe wall thickness, as well as the selection of a factor of safety called the Design Factor.

The Corrib Onshore Pipeline originally had a Design Factor of 0.72 which corresponds to the Design Factor required for a pipeline to be located in a rural area. Subsequently a more conservative Design Factor of 0.3 was adopted following a recommendation from Advantica in their Independent Safety Review. It might be noted that the factor of safety of a pipeline is essentially the inverse of the Design Factor, so adopting a Design Factor of 0.3 greatly increases the factor of safety involved, and *inter alia* leads to a pipe with a greatly increased wall thickness. In itself, this contributes significantly to the safety of the Onshore Pipeline.

The calculation of the minimum pipeline wall thickness is described in Appendix Q6.2. The nominal wall thickness is calculated as 27.1mm, which includes a corrosion allowance of 1mm.

7.1.2 Proximity to Normally Occupied Buildings

The Code requirements, and relevant calculations, with respect to proximity to normally occupied buildings, are described in Appendix Q 6.2.

In summary, I.S. 328 and BS PD 8010 prescribe the minimum distance that must separate a gas pipeline from existing normally occupied buildings, which is called the Building Proximity Distance. This distance is either derived from graphs or, in the case of BS PD8010, calculated using a formula that is based on a number of factors such as the Design Factor, the pipe diameter, the pipe wall thickness and the operating pressure of a pipeline.

The Building Proximity Distance for the Onshore Pipeline, based on its pipe-wall thickness of 27.1mm, the MAOP of 100 barg and a Design Factor of 0.3 is 3 metres – as derived in accordance with graphs in I.S. 328 and BS PD 8010 i.e. the two Codes both allow the Onshore Pipeline to be located 3 metres from normally occupied buildings.

If a Design Factor of 0.72 was applied, then the necessary pipe wall thickness would decrease significantly, and the required Building Proximity Distance for an MAOP of 100 barg would then be 63 metres when calculated in accordance with the graph in I.S. 328, and 60.4 metres when calculated by the formula in BS PD 8010.

The Building Proximity Distances calculated in accordance with the Codes reflect the very low probability of any possible incidents occurring, which is derived in the Quantitative Risk Assessment, discussed below.

The closest normally occupied building to the Corrib Pipeline is taken as 234m, which is substantially in excess of the Code minimum requirements.

7.2 QUALITATIVE RISK ASSESSMENT

A Qualitative Risk Assessment is presented in Appendix Q6.3 and provides an overview of the identified risks pertaining to the Onshore Pipeline and assesses those risks in a rigorous fashion.

Given the extremely low levels of public risk associated with the Onshore Pipeline, the scope for determining numerical benefit from further, more detailed, risk reduction measures is limited by the sensitivity of the Quantitative Risk Assessment (QRA). The principal means for assessing the benefit from additional risk reduction measures has therefore been via the qualitative approach. The Qualitative Assessment concludes by demonstrating that the risks associated with the pipeline have been reduced to levels that are As Low As Reasonably Practicable (ALARP).

The output from the qualitative assessment has provided a key input to the QRA in support of the screening and selection of potential failure modes for inclusion in the QRA and in support of the adoption of modifiers to historical data used within the QRA to establish base case failure frequencies.

The qualitative risk assessment presented generally aligns with the Petroleum (Exploration and Extraction) Safety Act and with the published guidance from the Commission for Energy Regulation (CER) for the preparation of Safety Cases.

7.3 QUANTITATIVE RISK ASSESSMENT

A Quantitative Risk Assessment (QRA) of the Onshore Pipeline is presented in Section Q6.4.

The QRA predictions provide a numerical estimate of the residual public safety risks associated with ignited hydrocarbon gas releases from the pipeline and Landfall Valve Installation in terms of:

- Individual risk of receiving a dangerous dose of thermal radiation
- Societal risk
- Distances to the boundaries of Inner, Middle and Outer zones. These zones were specified in the letter of the 2nd November 2009 from An Bord Pleanála, which requested SEPIL to represent the distance from the pipeline at which risk levels of $1x10^{-5}$, $1x10^{-6}$ and $0.3x10^{-6}$ per kilometre of pipeline per year exist

The QRA has been carried out in accordance with the methodology in BS PD 8010 Part 1 and BS PD 8010 Part 3 and applies the risk criteria adopted by An Bord Pleanála as outlined above and described in their letters dated 2nd November 2009 and 29th January 2010.

The overall conclusion from the QRA is that the predicted levels of risk associated with the proposed pipeline and LVI pose an extremely low risk to members of the public and the occupants of dwellings along the route of the pipeline.

In support of this conclusion the results of the QRA are summarised below. Figure 7.2, extracted from the QRA, presents the Risk Transect for the base-case analysis of the pipeline.

Pipeline:

- The predicted level of individual risk of receiving a dangerous dose or more at the nearest dwelling to the pipeline is $1.8x10^{-11}$ per year (i.e. 1.8 chances in every 100,000,000,000 years). This is an extremely low risk and is almost 100,000 times, below the level of risk described by An Bord Pleanála in their correspondence as 'broadly acceptable' ($1x10^{-6}$ per year i.e. one chance in 1,000,000 years)
- The predicted level of individual risk of receiving a dangerous dose or more standing at the pipeline is $2.9x10^{-9}$ per year (i.e. 2.9 chances in every 1,000,000,000 years); this is also well below the aforementioned $1x10^{-6}$ per year level.
- It is not possible to plot the boundaries of the inner, middle and outer zones for the pipeline as requested in An Bord Pleanála's letter of 2nd November 2009 as these levels of risk are not reached.

- The societal risk associated with the pipeline is also very low, being almost six orders of magnitude, or 1,000,000 times, below the criterion line for 'broadly acceptable'.

The above conclusions are drawn based on what is regarded by SEPIL to be the most appropriate application of data, assumptions and rule-sets specific to the Corrib pipeline. However, a number of sensitivity studies using more onerous frequencies and assumptions have been carried out to test the QRA predictions, these sensitivity studies include the inclusion of a frequency for ground movement and variations in parameters used within modelling rule-sets. The outcome of all the sensitivity studies is that the risk levels remain well within the 'broadly acceptable' region.

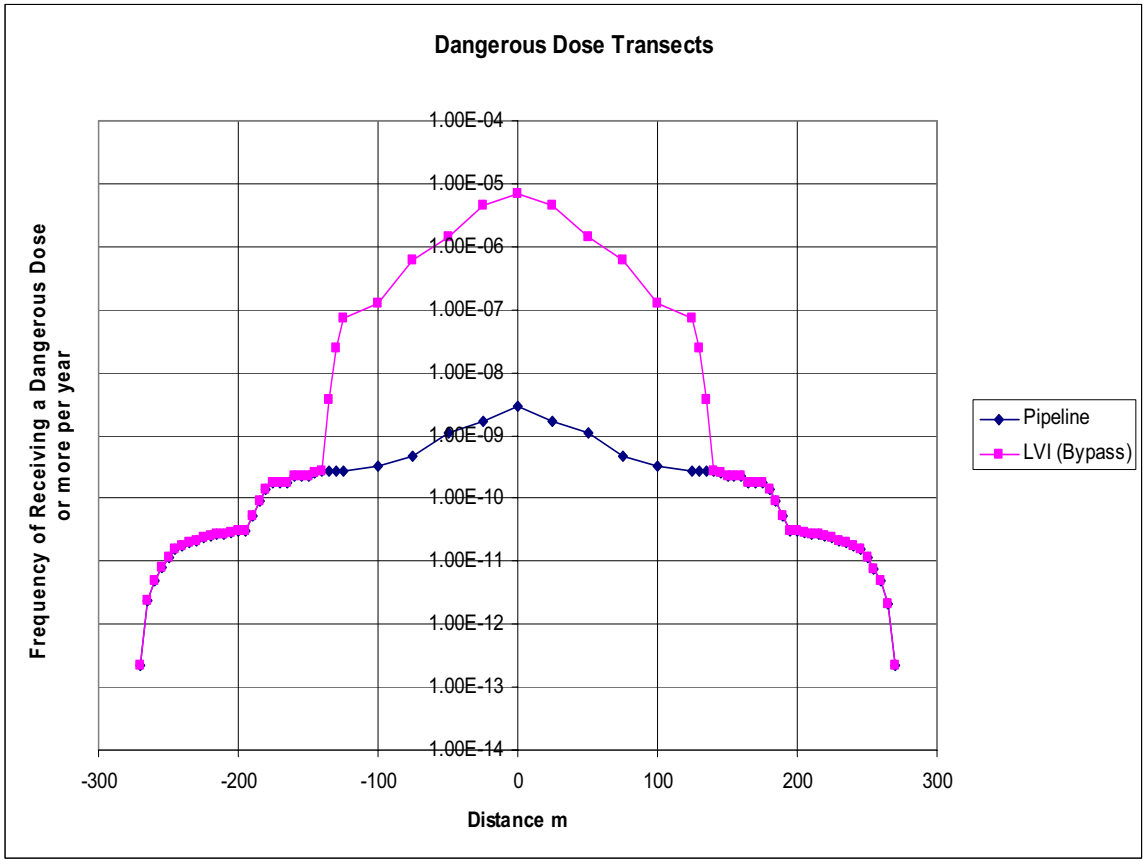
LVI:

- The predicted levels of individual risk of a receiving dangerous dose or more from the LVI are such that the $1x10^{-6}$ per year contour is 63m from the facility. For comparison it should be noted that the nearest dwelling is 280m from the LVI.

- The predicted distances from the LVI to the middle and outer zone outer boundaries are 63m and 91m respectively. The predicted risk level at the LVI is just below $1x10^{-5}$ per year, which is the outer boundary of the inner zone.

Applying a sensitivity analysis to the valve failure frequency in the LVI QRA base case gives predicted distances from the LVI to the outer boundaries of the inner, middle and outer zones of 111m, 124m and 132m respectively.

Figure 7.2: Risk Transect for the Onshore Pipeline



7.4 PROXIMITY DISTANCE DEFINED BY REQUIREMENTS SET BY AN BORD PLEANÁLA

An Bord Pleanála, in its letter dated 2nd November 2009, requested SEPIL to

> *'Adopt a standard for the Corrib upstream untreated gas pipeline that the routing distance for proximity to a dwelling shall not be less than the appropriate hazard distance for the pipeline in the event of a pipeline failure. The appropriate hazard distance shall be calculated for the specific pipeline proposed such that a person at that distance from the pipeline would be safe in the event of a failure of the pipeline.'*

SEPIL sought clarification on the matter, which was provided by An Bord Pleanála, by letter dated 29th January 2010, which stated that:

> *In paragraph (b) (at top of page 2 of the Board's letter of 2nd November, 2009) the intent of the Board is to ensure that persons standing beside the dwellings will not receive a dangerous dose of thermal radiation in the worst case scenario of a "full bore rupture" of the pipeline at maximum pressure.'*

In the Executive Summary of this Introduction, SEPIL commented that it does not consider that the principle of the application of consequence based criteria, in isolation from extremely low likelihood of a worst-case event, should be applied as a criterion in determining the location of gas pipelines. Notwithstanding this, SEPIL has calculated the separation distance, in accordance with the approach specified in the correspondence from An Bord Pleanála. These calculations are presented in Appendix Q6.5, which concludes:

For the worst conceivable full-bore rupture scenario and assuming immediate ignition, then:

- A person standing beside the nearest dwelling to the pipeline would be safe as they would be able to reach the shelter of that dwelling.

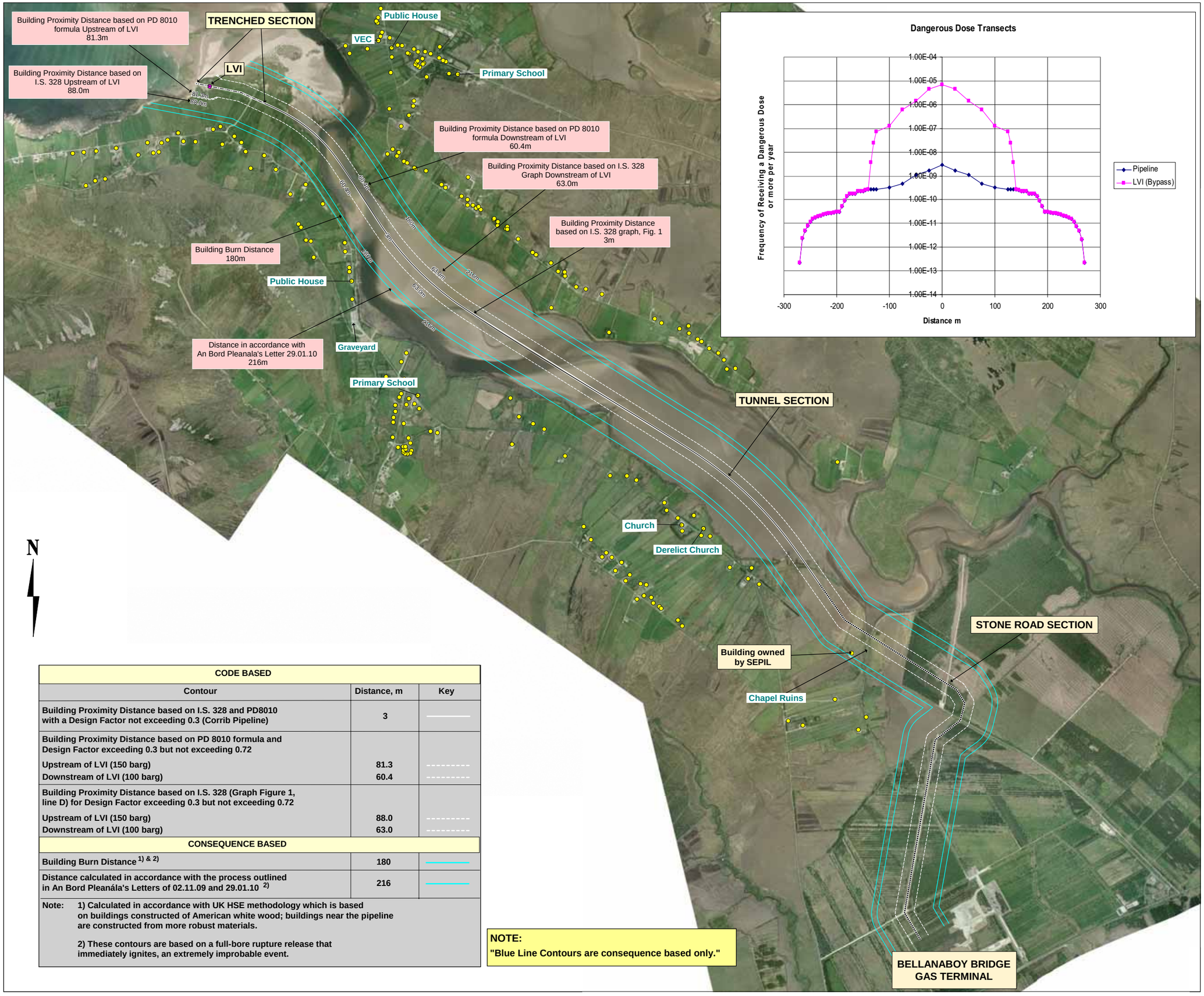
- All existing normally occupied dwellings provide safe shelter.

It can be concluded from the above consequence predictions that the pipeline design meets the defined safety criteria.

A Plot of risk and consequence based contours relative to the Onshore Pipeline and LVI is presented in Figure 7.3. The full set of contour plots is included in Appendix Q6.5(i).

7.5 EMERGENCY RESPONSE PLANNING & PROVISIONS

Appendix Q6.6, Emergency Response Planning and Provisions, documents the initial draft of the emergency response planning and provisions which, whilst a work-in-progress, clearly illustrate the intent with respect to managing emergency response and describes the plans for engaging with, and involving the public and the emergency services.



CODE BASED		
Contour	**Distance, m**	**Key**
Building Proximity Distance based on I.S. 328 and PD8010 with a Design Factor not exceeding 0.3 (Corrib Pipeline)	3	
Building Proximity Distance based on PD 8010 formula and Design Factor exceeding 0.3 but not exceeding 0.72		
Upstream of LVI (150 barg)	81.3	
Downstream of LVI (100 barg)	60.4	
Building Proximity Distance based on I.S. 328 (Graph Figure 1, line D) for Design Factor exceeding 0.3 but not exceeding 0.72		
Upstream of LVI (150 barg)	88.0	
Downstream of LVI (100 barg)	63.0	
CONSEQUENCE BASED		
Building Burn Distance [1) & 2)]	180	
Distance calculated in accordance with the process outlined in An Bord Pleanála's Letters of 02.11.09 and 29.01.10 [2)]	216	

Note: 1) Calculated in accordance with UK HSE methodology which is based on buildings constructed of American white wood; buildings near the pipeline are constructed from more robust materials.

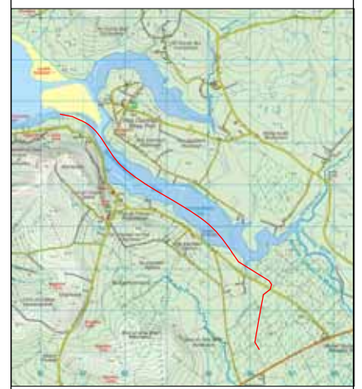
2) These contours are based on a full-bore rupture release that immediately ignites, an extremely improbable event.

NOTE:
"Blue Line Contours are consequence based only."

LEGEND

Proposed Route:

- Trenched Section
- Tunnel Section
- Stone Road Section
- House Location



Consequence and Code Based Contours

Figure 7.3

File Ref: COR25MDR0470Mi2471R04
Date: May 2010

CORRIB ONSHORE PIPELINE

Corrib natural gas

RPS

ATTACHMENT Q1A

Cross-reference to responses made to items raised by An Bord Pleanála in their correspondence

Table A1: Issues and requests for Further information raised by An Bord Pleanála in their correspondence and cross-reference to SEPIL's Responses

Item No.	An Bord Pleanála Request for Further Information items (2nd November 2009)	EIS section
Top of page 2	…the Board should, therefore, (a) adopt the UK HSE risk thresholds for assessment of the individual risk level associated with the Corrib Gas Pipeline, individual risk level above $1x10^{-5}$ – intolerable, individual risk level between $1x10^{-5}$ and $1x10^{-6}$ – tolerable if ALARP (As low as reasonably practicable) is demonstrated, individual risk level below $1x10^{-6}$ broadly acceptable, and	App Q6.4 (Section 8.3 and Fig. 13)
Top of page 2	(b) adopt a standard for the Corrib upstream untreated gas pipeline that the routing distance for proximity to a dwelling shall not be less than the appropriate hazard distance for the pipeline in the event of a pipeline failure. The appropriate hazard distance shall be calculated for the specific pipeline proposed such that a person at that distance from the pipeline would be safe in the event of a failure of the pipeline.	App Q6.5(i)
(a)	Clarify the code requirements and pressure test requirements for the pipeline from chainage 83+390 (HWM) approx. to chainage 83+470 (downstream weld at LVI)	App Q2.1 (Section 3 & Section 5.4)
(b)	Provide confirmation that the design of this section of the pipeline meets the requirements set down by the Technical Advisory Group (TAG).	App Q2.1 (Section 3)
(c)	Provide an integrated set of design documentation in the form of a revised Appendix Q.	App Q
(c)1	The documentation should integrate the analysis provided in the incidental and individual documents at the oral hearing.	App Q & App Q1 (Attachment Q1B, Table B1)
(c)2	The whole set should provide a transparency of the design for the complete pipeline from the HWM to the terminal. This transparency should relate to the different site and design conditions along the pipeline and should relate to the codes.	App Q2.1 & App Q3.2
(c)3	The design should include the analysis related to ground stability	App Q4.1 (including Attachment Q4.1A) & App M2
(c)4	and should provide a system for monitoring movement of the pipeline in those areas of deep peat.	App Q4.1, Chapter 15 & App M2 (Section 8.5 & Drawing 001)
(c)5	Furthermore, the maximum allowable operating pressure (MAOP) for the pipeline should be stated.	App Q2.1 (Section 4.5) & App Q4.5 (Section 2)
(d)	Submit a new QRA that presents the analysis of risk at the different operating conditions and different locations along the pipeline route.	App Q6.4 (Table 9 & Section 8)
(d)1	The QRA should be site specific.	App Q6.4 (Table 9 & Section 8) & App M2
(d)2	The QRA should include ground movement and incorporate a database that matches the conditions of the proposed development.	Q6.4 (Section 6.4.5) & App M2/M3
(d)3	A sensitivity of the QRA is required which demonstrates the range of risk that relates to any uncertainty (in the database) of failure frequencies for the various potential failure modes of the pipeline.	App Q6.4 (Sections 7.4 & 8.7)
(d)4	The database should be relevant for an upstream wet gas.	App Q4.9 & Q6.4 (Sections 6.2 & 6.4.3.1)
(d)5	In order to eliminate any doubt please note that all failure modes should be included including the possibility of third party intentional damage at Glengad,	App Q4.10, App Q6.3 (Attachment Q6.3A, p. A5 and Attachment Q6.3B Fig. B4.5, p. B22) and Q6.4 (Section 6.4.7, Attachment B - Figs 18, 19 &

		Table 20)
(d)6	wet gas in the pipeline,	App Q4.7-4.9, App Q6.3 (Attachment Q6.3B, Figs. B3.4-B3.9 & Figs. B5.4-B5.9) & App Q6.4 (Sections 6.4.3 and 6.7.1.2)
(d)7	CO2 in the pipeline and	App Q4.7-4.9, App Q6.3 (Attachment Q6.3B, Figs. B3.4-B3.9 & Figs. B5.4-B5.9) & App Q6.4 (Sections 6.4.3 and 6.7.1.2)
(d)8	potential for Methane Hydrate in the pipeline.	App Q4.5 (Section 6), App Q6.3 (Attachment Q6.3B, Fig. B3.13) & App Q6.4 (Section 6.3.2.3)
(e)	Provide a qualitative assessment of risk. This should be prepared for the different operating conditions and different locations along the pipeline route and should provide a comprehensive assessment to include those events that cannot be easily defined mathematically.	App Q6.3
(f)	Submit an analysis of the condition where the umbilical becomes severed and the control of valves at the wellhead and the subsea manifold is lost. The analysis needs to identify what conditions apply to the onshore pipeline and the risks involved in that circumstance.	App Q4.5 (Section 3.2) & App Q6.3 (Section 4.4 & Attachment Q6.3B, Figs. B6.1-B6.4)
(g)	An examination of the potential for pressure in the offshore pipeline to increase to wellhead pressure levels in the event that all wellhead valves had to be shut in over a prolonged period and in that period incremental leakage past the valves occurred.	App Q4.5 (Section 4)
(g)1	The concept of a vent at Glengad as a measure to protect against pressure at the wellhead side of the pipeline at the landfall rising above the maximum operating pressure should be examined.	App Q4.5 (Section 7)
(g)2	Information should also be provided on the reliability of the subsea shut down valve system proposed for the wellhead and manifold offshore.	App Q4.6
(h)	Provide details of the examination of the potential increase in safety for the population at Glengad by the use of a straight pipe at the landfall and	App Q4.4
(h)1	provide full justification for the proposed design as submitted (and any revised design that may result from the modifications requested herein).	App Q4.3
(i)	Provide details of the hazard distances, building burn distances and escape distances in contours for the entire pipeline.	App Q6.5(i) & (ii)
(i)1	The applicant should indicate the outer hazard line contour which should show the distance from the pipeline at which a person would be safe. A number of these contours were provided at the oral hearing (copies of which are attached to this letter), however, the set of hazard contours should be complete and should include the entire onshore pipeline as far as the terminal.	App Q6.5(i)
(i)2	Please indicate the assumption made in determining these hazard contours and indicate any limitations that apply to these hazard contours.	App Q6.5(i) & (ii)
(j)	Provide details separately of the inner zone, middle zone and outer zone contour lines for the pipeline. These shall represent the distance from the pipeline at which risk levels of $1x10^{-5}$, $1x10^{-6}$ and $0.3x10^{-6}$ per kilometre of pipeline per year exist.	App Q6.4 (Section 8.6 and Fig. 15)
(k)	Provide an assessment of the societal risk for Glengad and the societal risk along the revised route. This should be fully documented.	App Q6.4 (Section 8.5)
(l)	Submit precise section by section details of the proposals for temporary peat turve storage, which take into account the condition of the existing surface layer of the peat and which specifically identify where peat turves or remoulded peat will be stored on bog mats adjacent to the stone road	App M2 (Section 5, Table 2 & Drawing 001)

	(or elsewhere).	
(m)	Submit details of the specific risk mitigation measures that would be proposed for each of the sections within the peat lands (Sections 1 to 18 were the relevant sections in the route as originally proposed and as set out in the qualitative assessment of relative peat failure potential which was presented as additional information at the oral hearing). These details should identify in particular where there would be limits on the storage of peat on bog mats adjacent to the stone road excavation and where a conservative approach would be proposed to the use of design factors and in the assessment of peat stability.	App M2 (Section 5, Table 2 & Drawing 001)
(n)	Submit an assessment of the potential impact of the estimated stone road settlements on the umbilical pipeline and service ducts that will also be constructed within the stone road,	App M2 (Section 8) & App Q4.1 including Attachment Q4.1A
(n)1	including an assessment of the risks associated with failure due to rupture of these umbilicals or services.	App Q4.5 (Section 3), App Q6.3 (Section 4.4 & Figs. B6.1-B6.4) & App Q6.4 (Sections 6.3.2.7, 6.4.5 & 8.1)
Page 4, para 1	Revised drawings should be submitted which fully describe the full extent of the onshore pipeline from the HWM to the terminal site.	Book of drawings & App A
Page 4, para 2	The site of the proposed development has been incorrectly detailed in the EIS between chainage 91.537 and chainage 92.539, i.e., the existing stone road at the Terminal end of the pipeline. The applicant is invited to amend the details of the proposed development at this location.	App M3 (Drawing DG0112R14)

Item No.	An Bord Pleanála Letter (29th January 2010)	EIS section
1	The Board's specific concern is that the undertaker should provide sufficient information and design detail to enable the assessment of whether or not the revised proposed development would give rise to an unacceptable risk to the public, having regard to the very high pressures involved, the site conditions through which the pipeline traverses and the hazards associated with the transport of untreated wet gas. It is a matter for the undertaker to provide sufficient information to enable the Board to assess the proposed development.	App Q
2	The UK HSE risk thresholds which are contained in paragraph (a) of the Board's letter relate to individual risk of receiving a dangerous dose of thermal radiation. It is the Board's understanding that the UK HSE framework for Tolerability of Risk uses 10^{-5}, for gas pipelines, as the boundary between "tolerable [ALARP]" and "intolerable" risk levels. The Board in paragraph (a) (at top of page 2 of the Board's letter of 2nd November, 2009) have set out the standard against which the proposed development will be assessed. In the event that individual risk of the 10^{-6} or higher applies then the undertaker will have to demonstrate ALARP.	App Q6.4 (Section 8.3 and Fig. 13)
3	In paragraph (b) (at top of page 2 of the Board's letter of 2nd November, 2009) the intent of the Board is to ensure that persons standing beside the dwellings will not receive a dangerous dose of thermal radiation in the worst case scenario of a "full bore rupture" of the pipeline at maximum pressure.	App Q6.5(i)
4	In respect of the pipeline at Glengad the undertaker is asked to provide full justification for the design proposed and the undertaker is asked to provide details of a design examination and safety evaluation of the use of an alternate layout at Glengad which would consist of a pipeline without a loop i.e. the alternative gas pipeline configuration should be considered to consist of a straight pipe at Glengad. In the interests of clarity the term straight pipe should be construed to mean a pipe without a loop and does not preclude the normal longitudinal profile from curvature and geometrical pipe layout with gradual bends to match the requirements of ground profile and other local requirements (streams etc).	App Q4.4

ATTACHMENT Q1B

Oral Hearing Analyses

Analyses provided at the Oral Hearing

Table B1 addresses the text highlighted in bold (which is part of point (c) in the letter from An Bord Pleanála (2/11/2009)):

(c) Provide an integrated set of design documentation in the form of a revised Appendix Q. **The documentation should integrate the analysis provided in the incidental and individual documents at the oral hearing.**

All previous analyses provided during the Oral Hearing, 2009 (in relation to Appendix Q) have been reviewed. Where possible the analyses have been incorporated directly. It should be noted that due to the re-routing and reduction in maximum allowable operating pressure that significant amounts of the analyses previously provided have been superseded by current information.

Table B1: Analyses provided at the Oral Hearing which have been integrated into the Appendix Q documentation

Document Title	Appendix Q section
An Bord Pleanála – Oral Hearing – June 4 2009-06-04 [Supplementary Information requested by the Bord from Phil Crossthwaite, DNV, QRA] – [Distances from jet flames & individual risk sensitivity transects]	Q6.4 (Section 8.1, Table 17) and Q6.4 (Section 6.4.5, Table 19, Figs. 16 & 17)
Fact sheet: umbilical leak	Q4.5 (Section 3)
Potential and Effect of Passing Valves in the Corrib Upstream Pipeline	Q4.5 (Section 4)
Qualitative Risk Management	Q6.3
Preservation of Linepipe pictures	Q5.4 (Figures 2.1 and 3.1)
Notes on the flexibility testing of 3LPP Coating at Bodycote, Eccles, on Pipe straps cut from stored pipe from the Shell Corrib Project and COT coating test results	Q5.4 (Attachment Q5.4B)
Fact sheet: Intelligent Pigging	Q2.1 (Section 9.5)
An Bord Pleanála – Oral Hearing – June 9 2009 [Ground movement transects]	Q6.4 (Section 6.4.5, Fig. 12, Table 19, Figs. 16 & 17)
Explanatory Note 1: Consequence Impact Contour Maps	Q6.5(ii)
Additional Information for An Bord Pleanála for the Corrib gas pipeline application (DNV QRA) [Information on dispersion]	Q6.4 (Attachment C)
Onshore Pipeline Stone Road Settlement Analysis	Q4.1 (Attachment Q4.1A)
Maximum length of a single length offshore umbilical	Q4.1 (Section 6)
Pressure Regime: Subsea to BGE and Corrib Key High Pressure Trips	Q4.5 (Section 2)
Proximity of Pipeline Route to Local Housing (Drawing)	Appendix A2 (File ref. COR25MDR0470Mi2132A5)
Summary of Corrosion Management of Wet Gas Pipelines	Q4.9 (Section 2.3)
UPDATED Explanatory Note 1: Consequence Impact Contour Maps	Q6.5(ii)
Additional Information - Inspection of the pipeline within the tunnelling bundle	Q4.7 (Section 4.3.1 & 7.2.3)
An Bord Pleanála - Further Information on Dispersion of gas from a hole in the pipeline	Q6.4 (Attachment C)

Table B2: Other information and reports provided at the Oral Hearing

Document Title
Upstream Pipeline and Facilities Statutory Risk Assessment Regime in the Netherlands
Supplementary information presented to An Bord Pleanala for the Corrib gas pipeline application by Phil Crossthwaite, DNV [Response to question regarding hazard distance from 2004 Bellanaboy Bridge Gas Terminal QRA]
Offshore pipeline system: long range tie-back study (Granherne) (Sept. 2002)
Corrib Gas Pipeline Project – Report on Evaluation of Onshore Pipeline Design Code (by Andrew Johnston) (28/03/2002)
Advantica Independent Safety Review of the Onshore Section of the Proposed Corrib Gas Pipeline (17/01/2006)
Report of the Corrib Technical Advisory Group to Minister Dempsey (27/01/06)

The information and reports shown in Table B2 (above) were also provided at the Oral Hearing, 2009, but as they are not analyses they are not integrated into the current Appendix Q documentation. The above list is included for completeness.